Characterization of Cloud-Cleared Radiances

Evan Fishbein

Luke Chen

JPL

Theoretical Basis for Cloud-Clearing

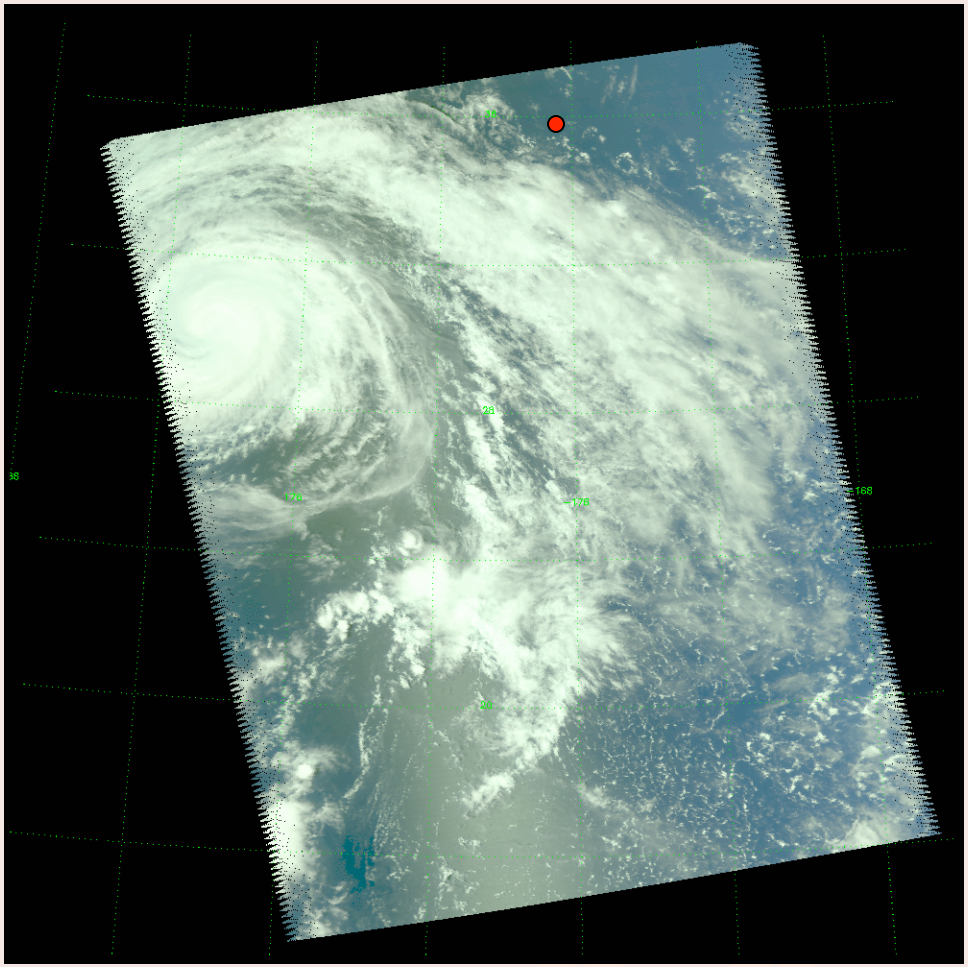
- Predict clear radiances from microwave radiances
- Estimate cloud fractions from cloudy-clear radiance residuals (predictor radiances)
- Extrapolate all radiances to clear conditions

3 Study Footprints Presented

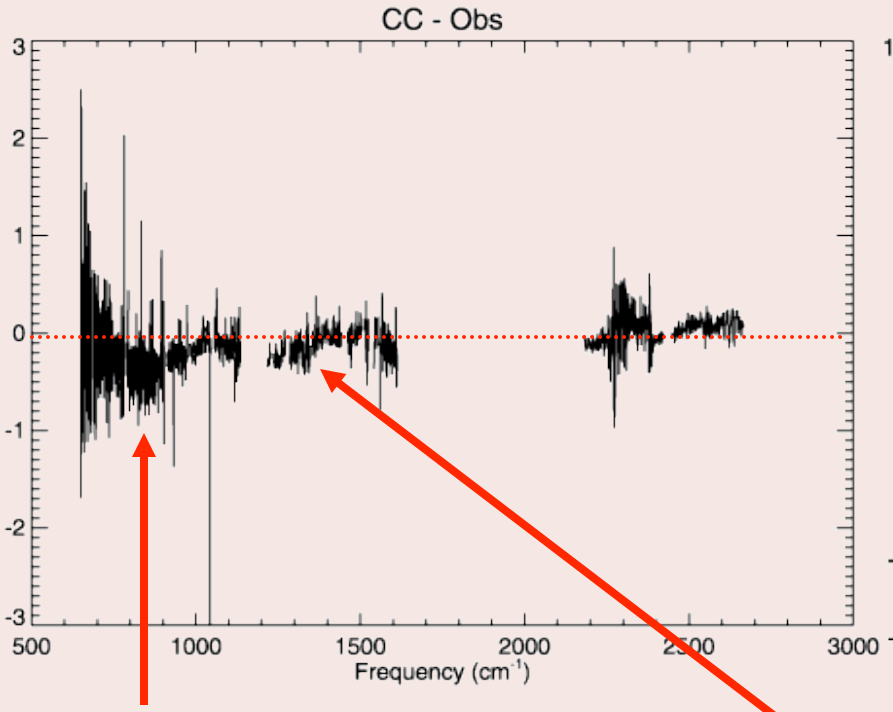
1. Footprint identified clear using clear-sky discriminants, and almost clear by retrieval
2. Footprint identified clear by retrieval, but cloudy by discriminants
   - Contamination by stratocumulus
3. Footprint identified as cloudy
   - Contaminated by tropical cumulus

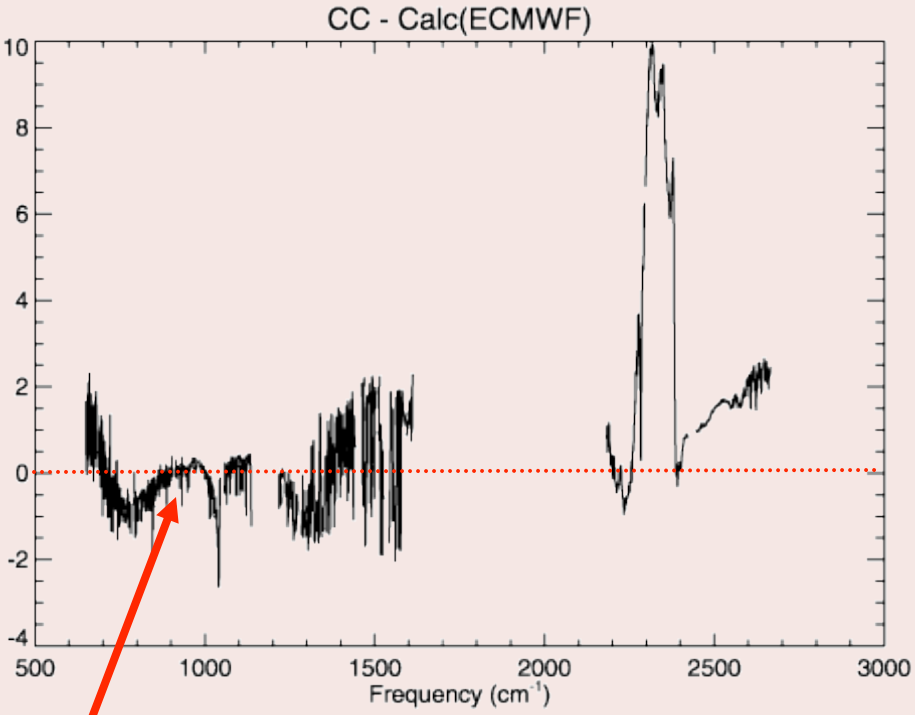
Cloud-Free Region

- 6 September 2003
- G/S/F: 26/10/39
  (Granule/Scanline/Footprint)
- Noise Amplification Factor (NaF) 1.28
- LW Coherency: 0.05K
- LW SST Pred Err: 0.26K



Cloud-Cleared



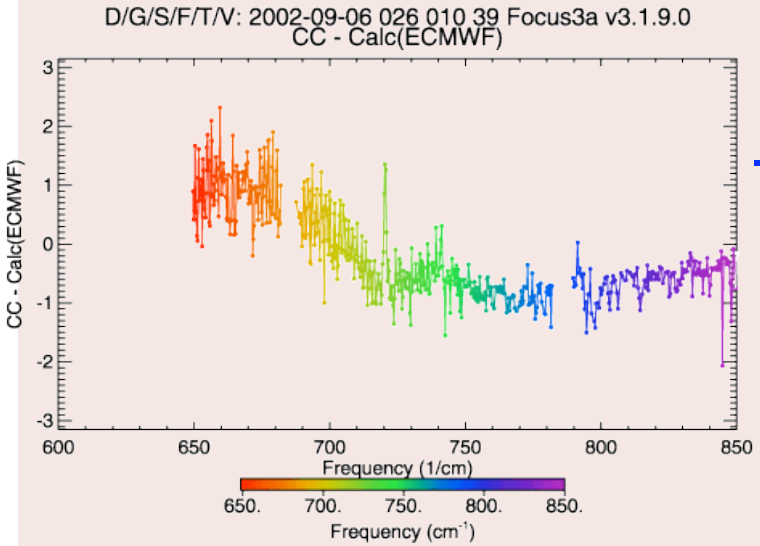


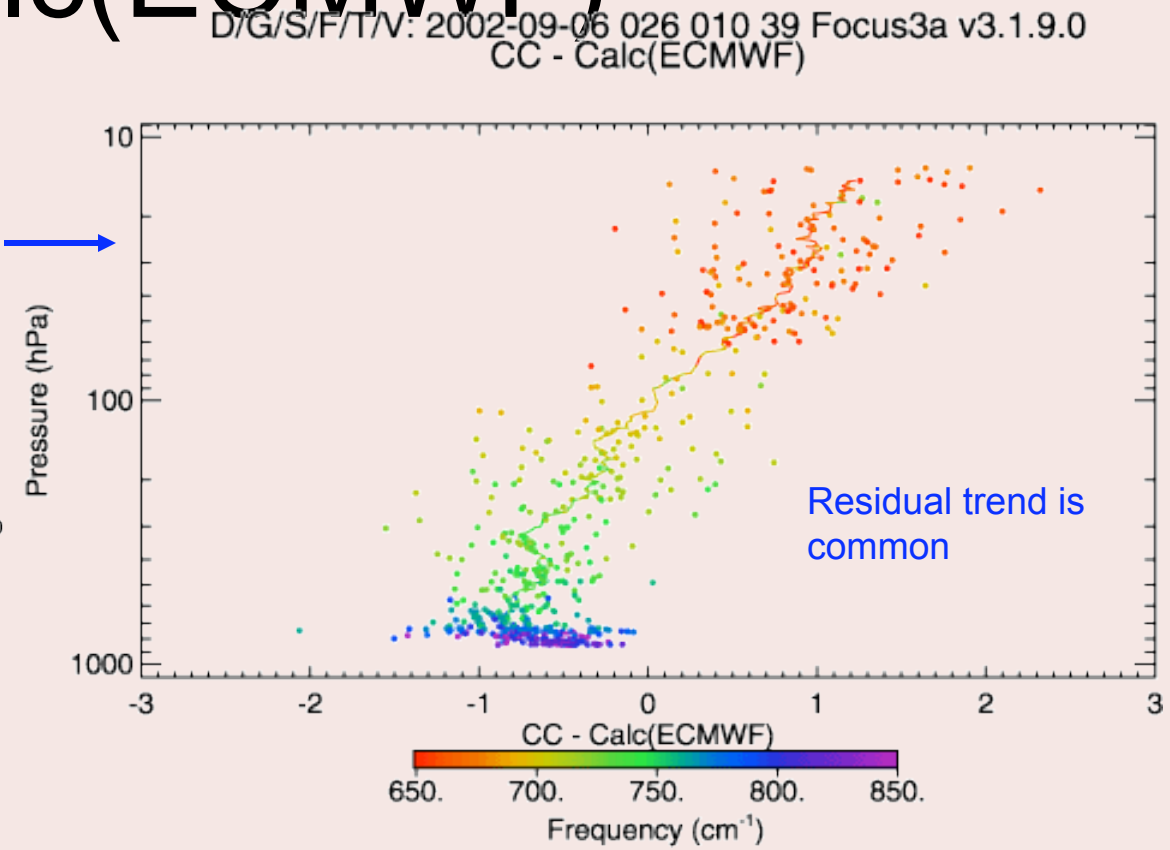
Surface Channels with larger bias

CC and Observed are within 0.2K in these surface channels.

CC and ECMWF-calculated are within 0.2K in these surface channels

Cloud-Cleared – Calc(ECMWF)



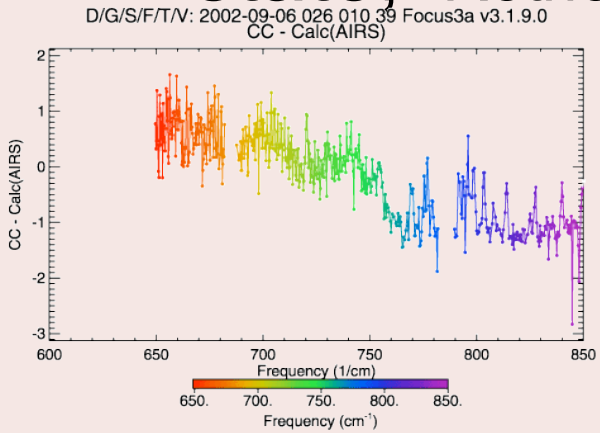


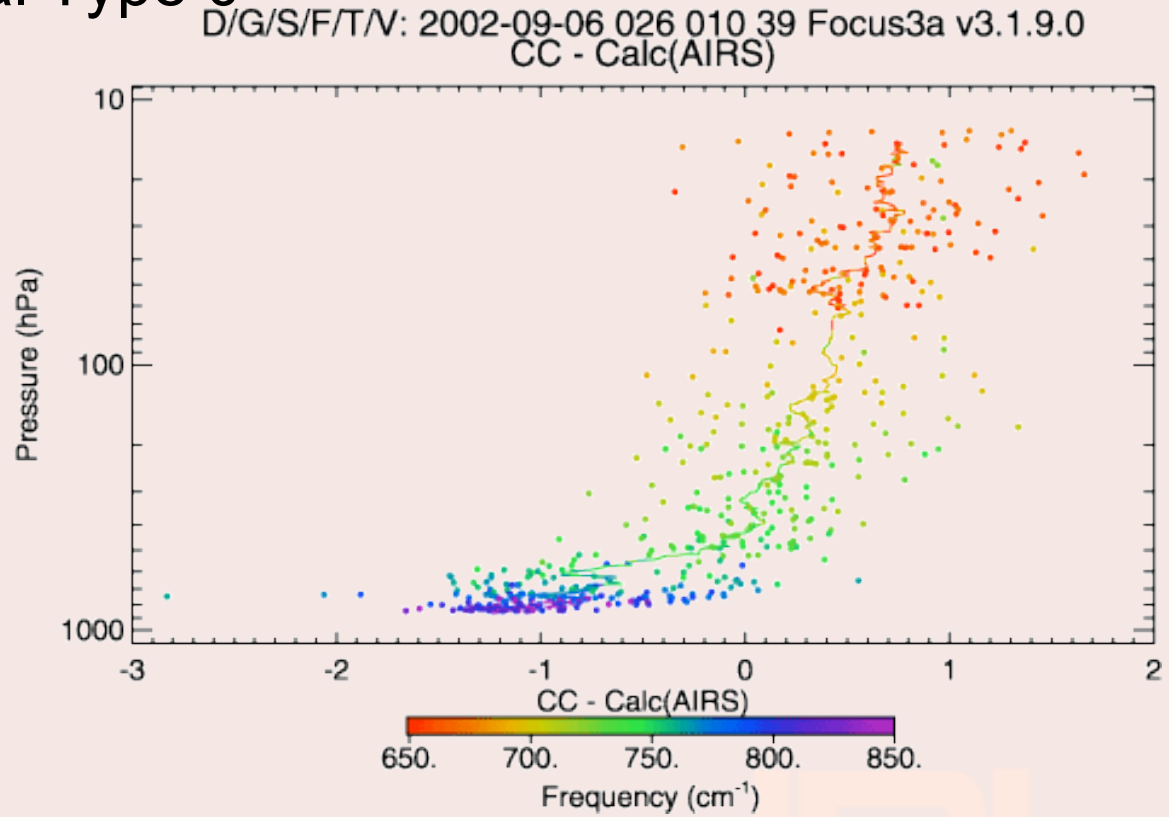
Map radiances onto pressure using P centroid of weighting functions.

Smoothed differences shown by line (method is dubious near surface)

Cloud-Cleared – Calculated

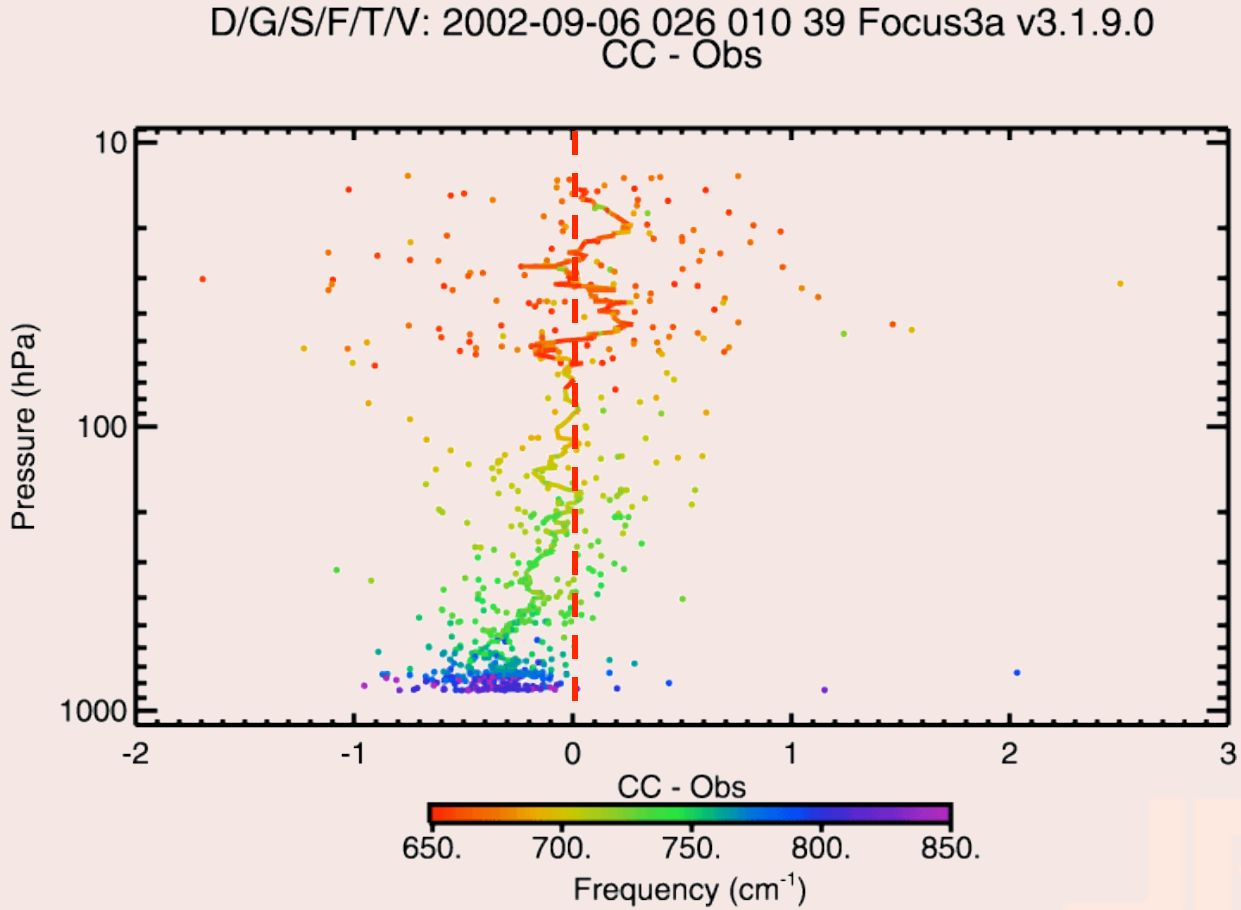
- CC Radiances calculated from retrieved state, Retrieval Type 0





Cloud-Cleared – Observed

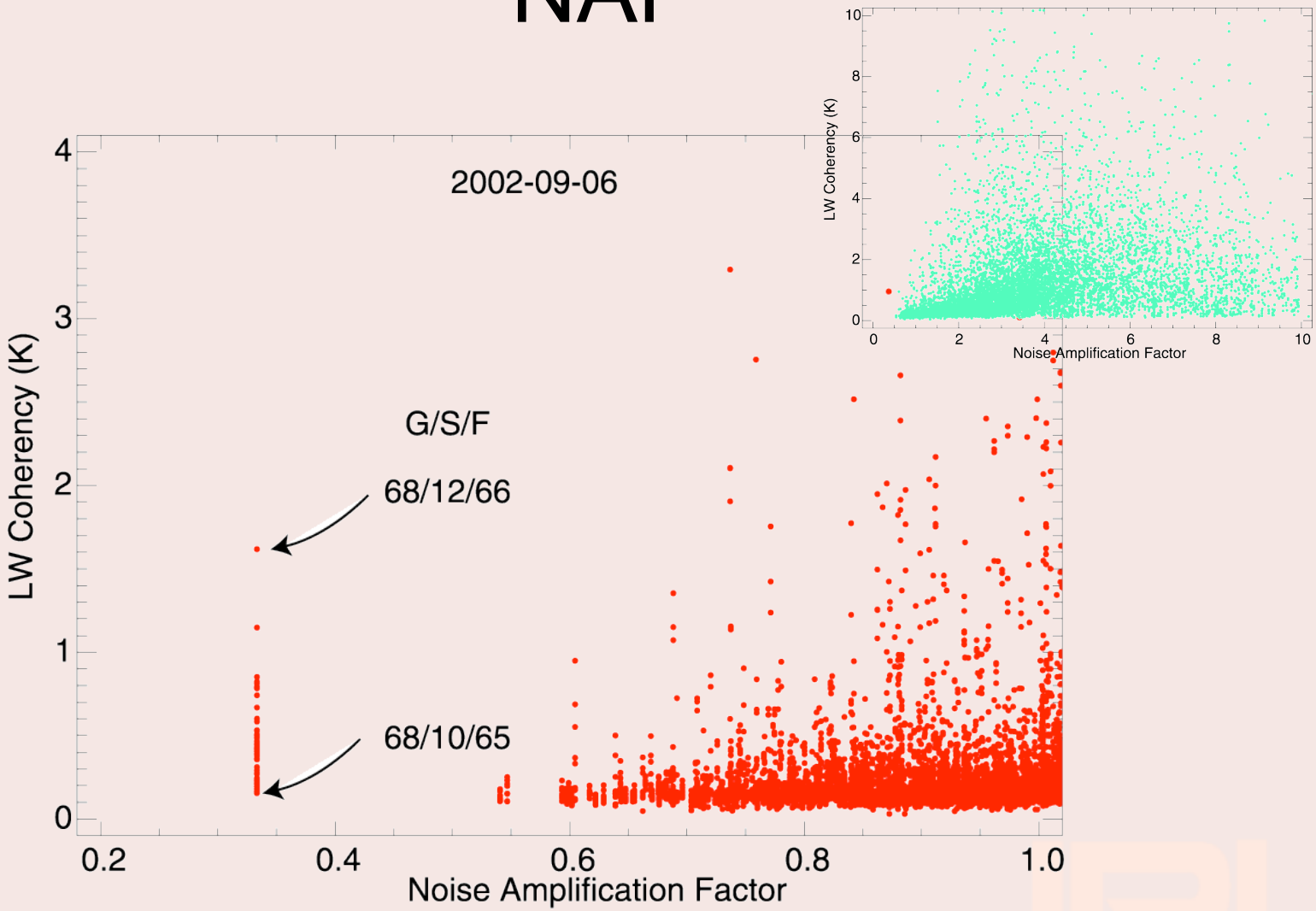
- Cloud-cleared radiances are biased cold in lower troposphere, but should always be warmer than Obs.



Radiance Residual-Retrieved Solution

- Radiances derived from solution agree with observations through out most of the troposphere
- Poorer agreement near surface and in stratosphere.

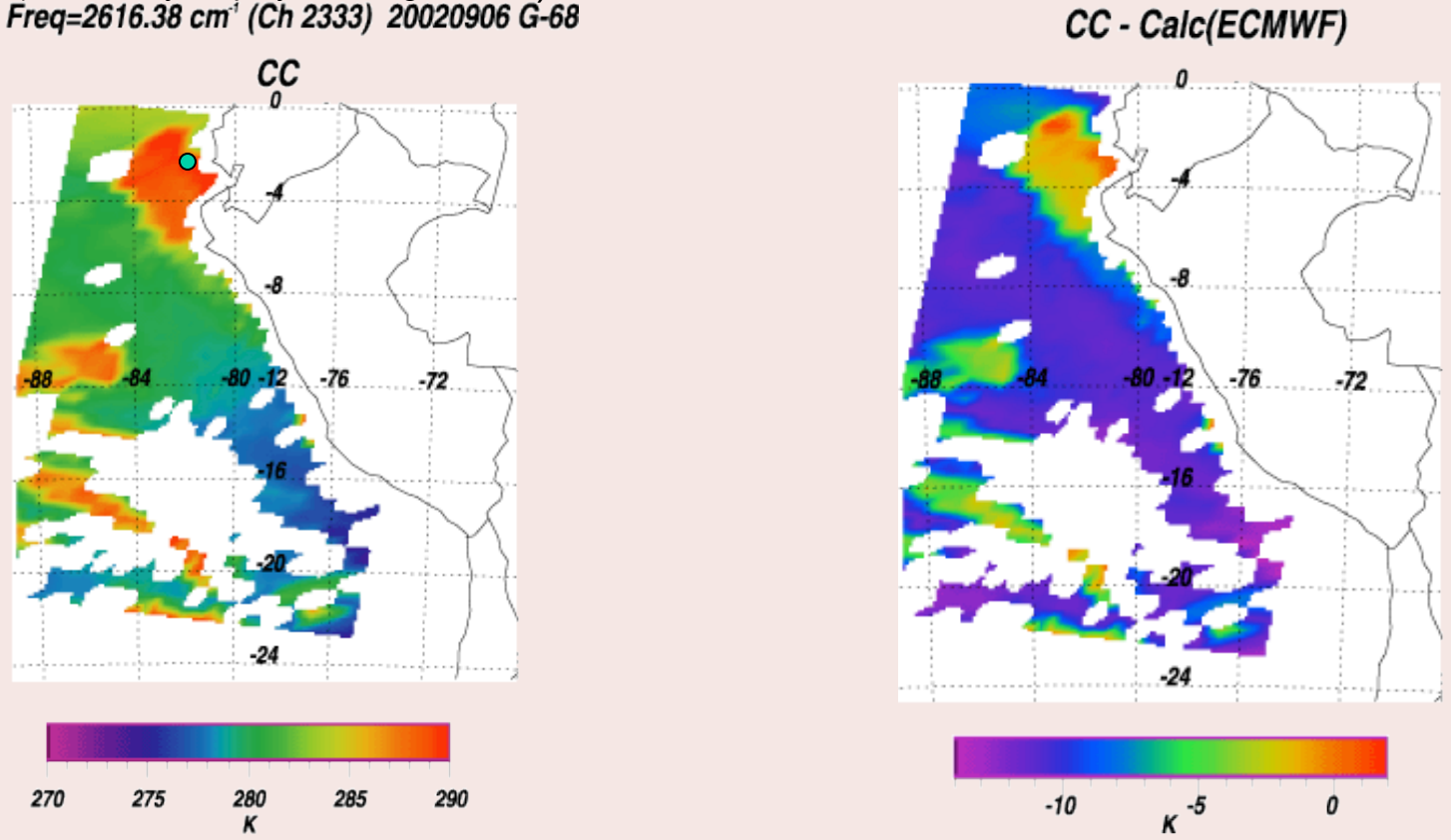
Footprint Diagnosed Clear by NAF



Cloudy Region Flagged Clear

- Retrieval Set contains both G/S/F: 68/12/66 and 68/10/65 (Night)

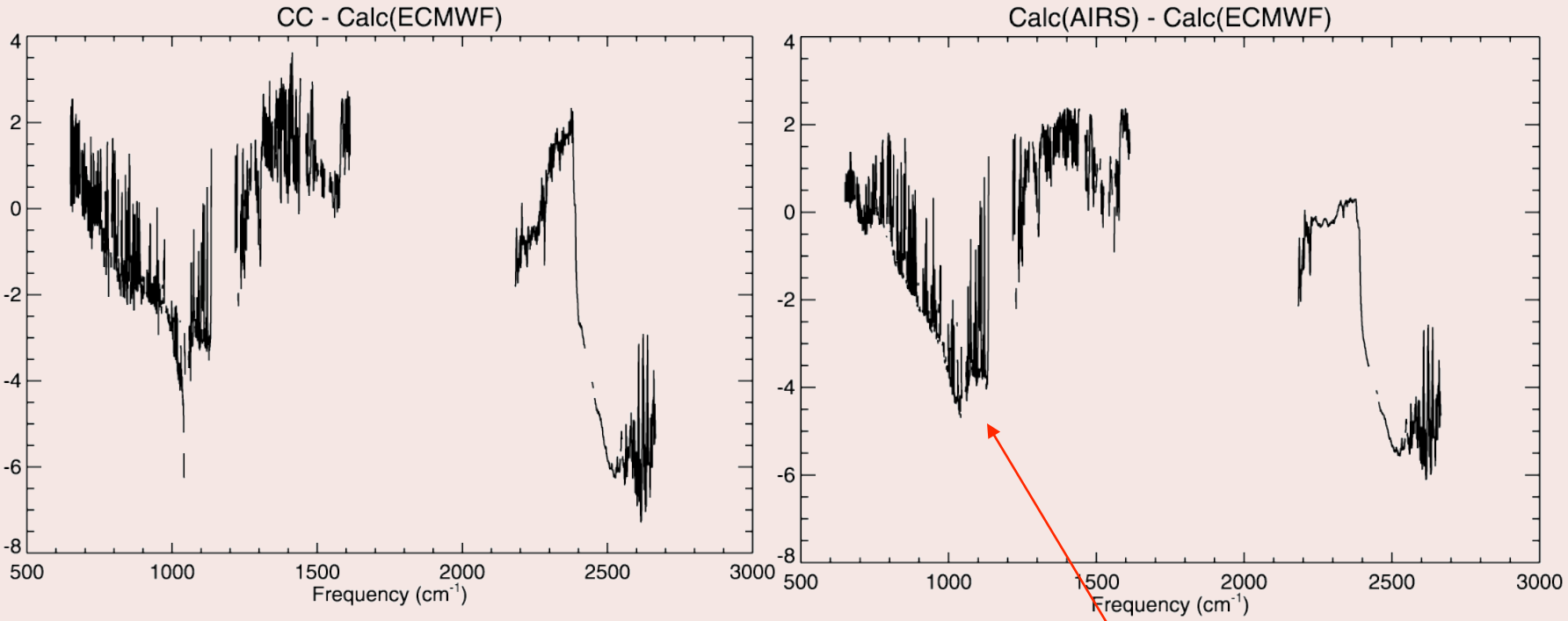
(Coherency employs moving window)



Low Stratocumulus

Coast of Peru

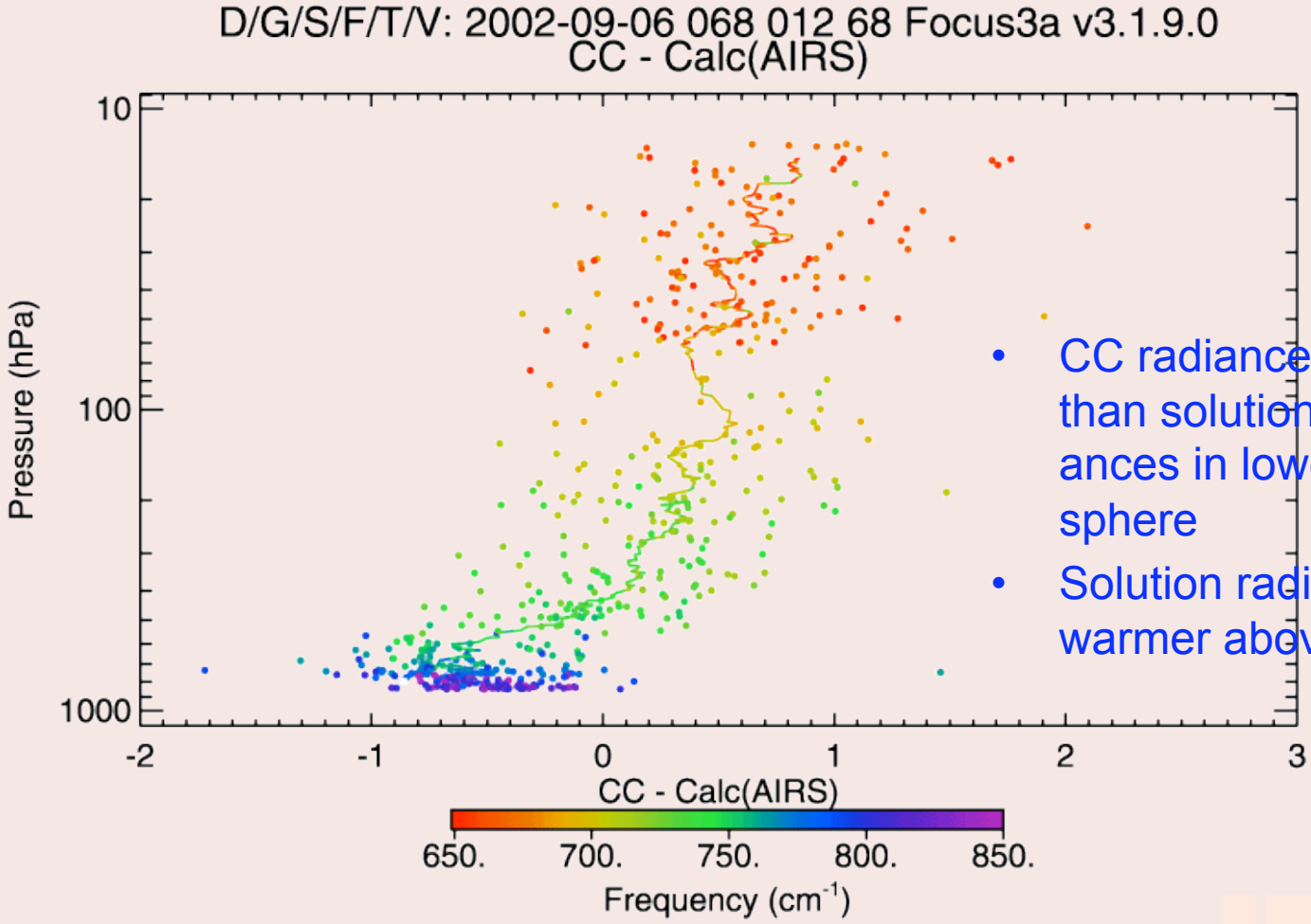
Radiance Comparison
with ECMWF



Observed and Cloud-cleared radiances are the same

Difference with ECMWF shows spectra signature of water clouds

Consistency of Cloud-cleared and Fitted Radiances



- CC radiances are warmer than solution-derived radiances in lower troposphere
- Solution radiances are warmer above clouds

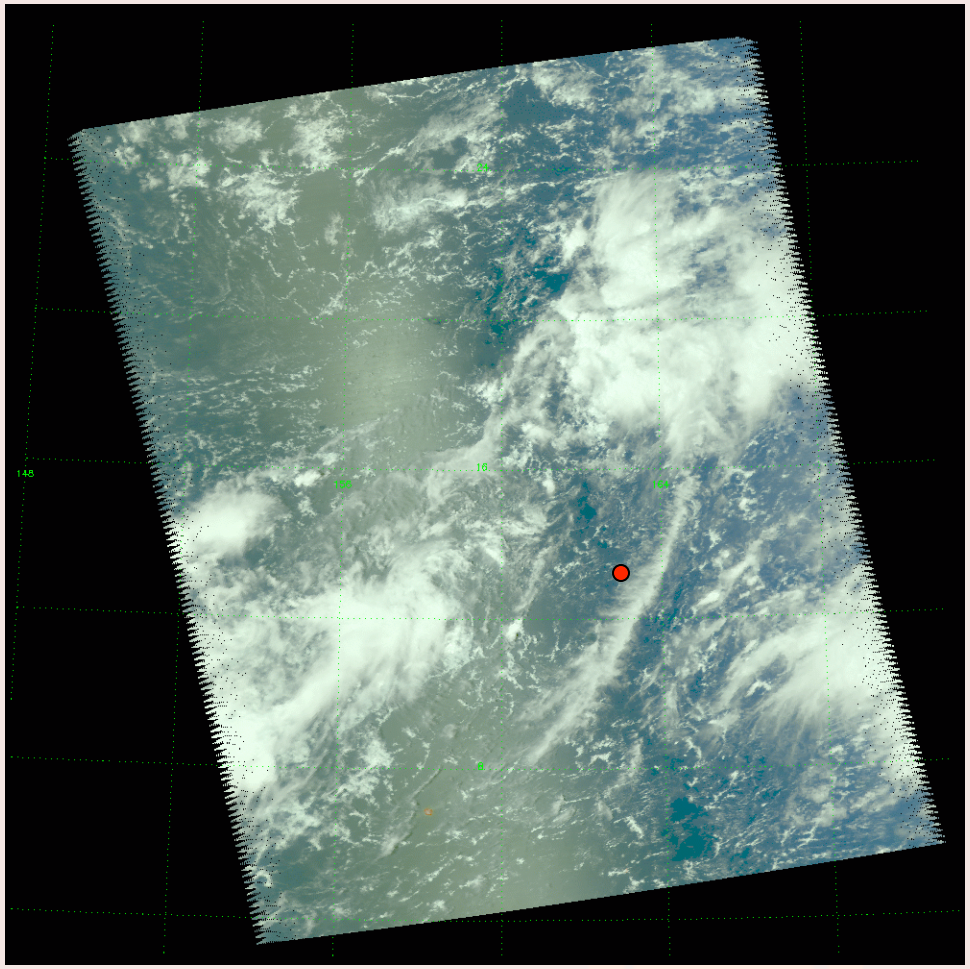
Effects of Stratocumulus

- Radiances contain information not used by retrieval
- Signature of liquid water clouds
- Radiance difference, indicative of noise does not show noise attenuation from radiance averaging (NaF = 0.33)
- Fit to radiances within 1K in 1 km layers

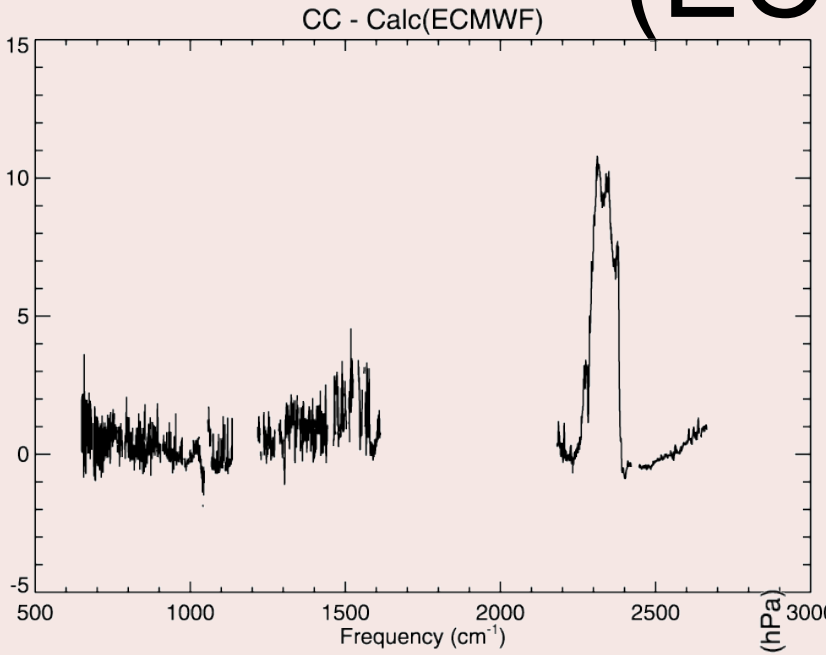
Tropical Cumulus

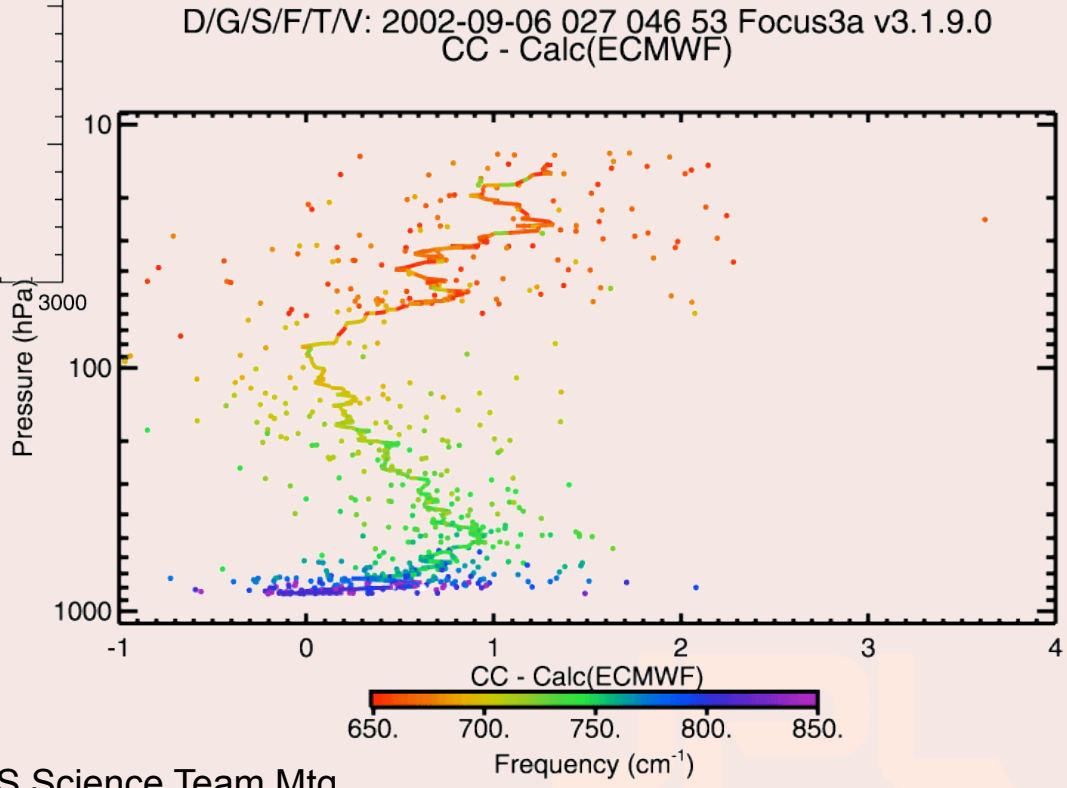
- Tropical Western Pacific
- GSF: 27/46/53
- 12.26 ° N, 161.7° E
- NaF: 3.1

- Leading edge of squall

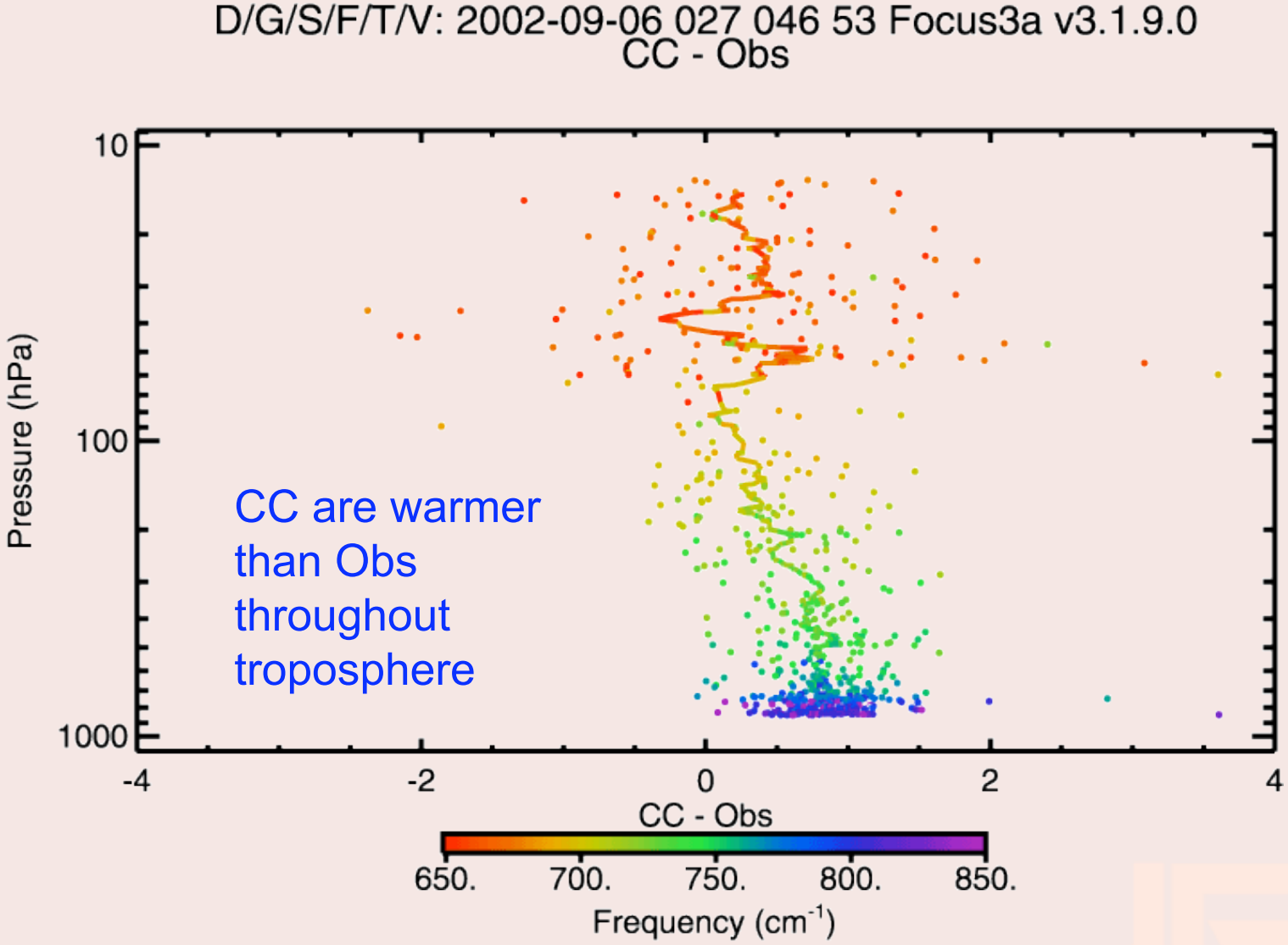


Cloud-cleared – Calc (ECMWF)

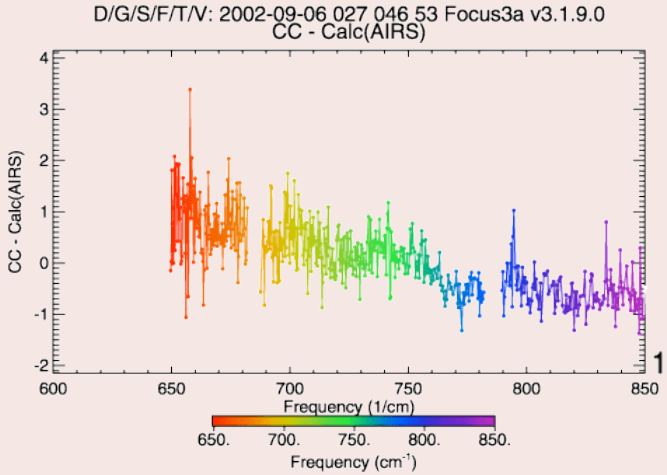


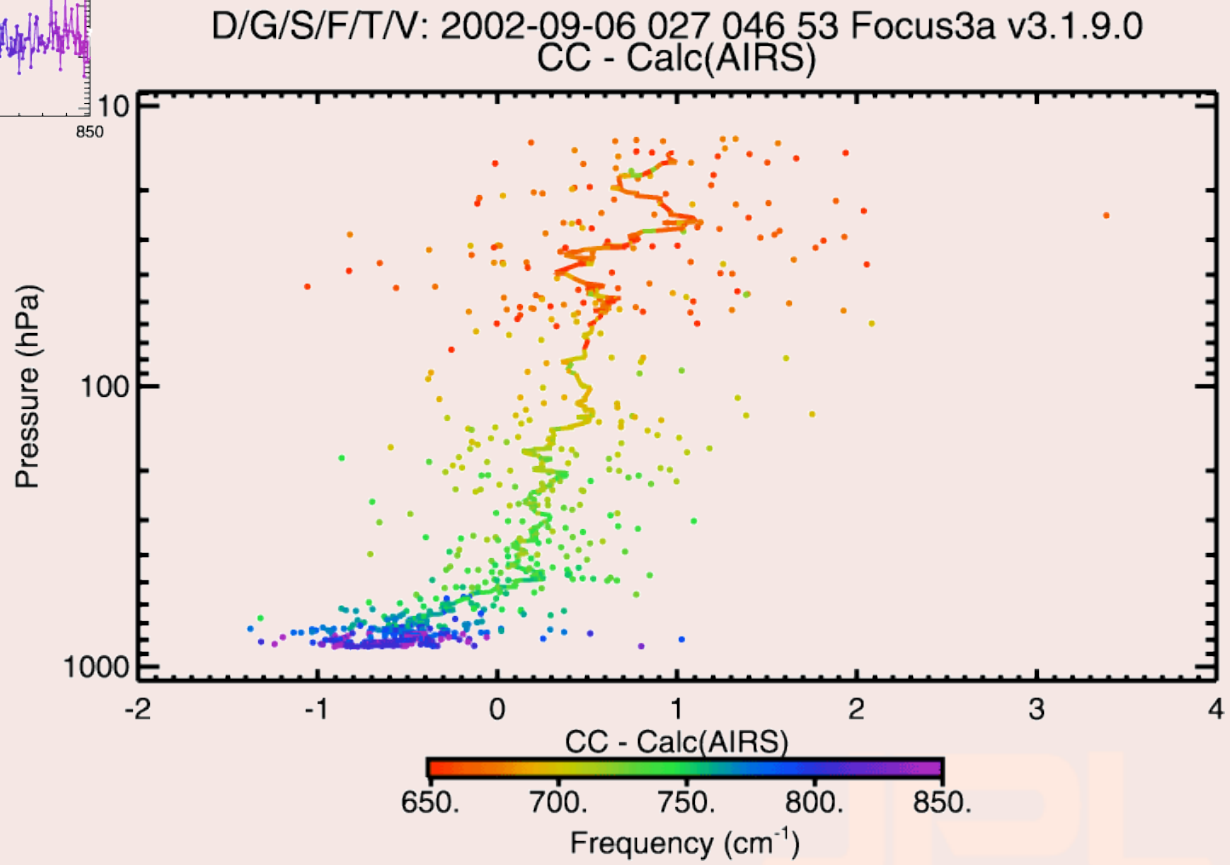


Cloud-cleared – Obs



Cloud-cleared – Calc(Retrieval)





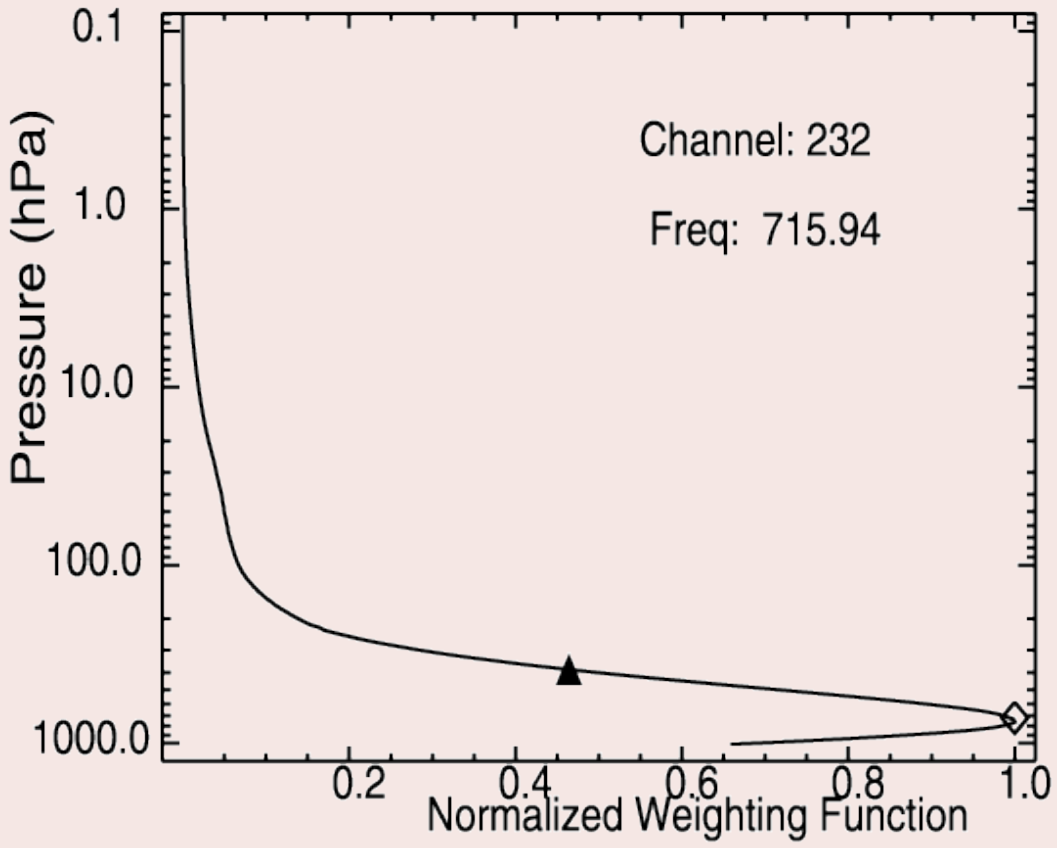
Fitted radiances match CC to 0.5K through mid and upper troposphere

Retrieval in the Presence of Tropical Cumulus

- Cloud correction is positive
  - i.e. clouds are cold
- Improved closure between fitted and cloud-cleared radiances

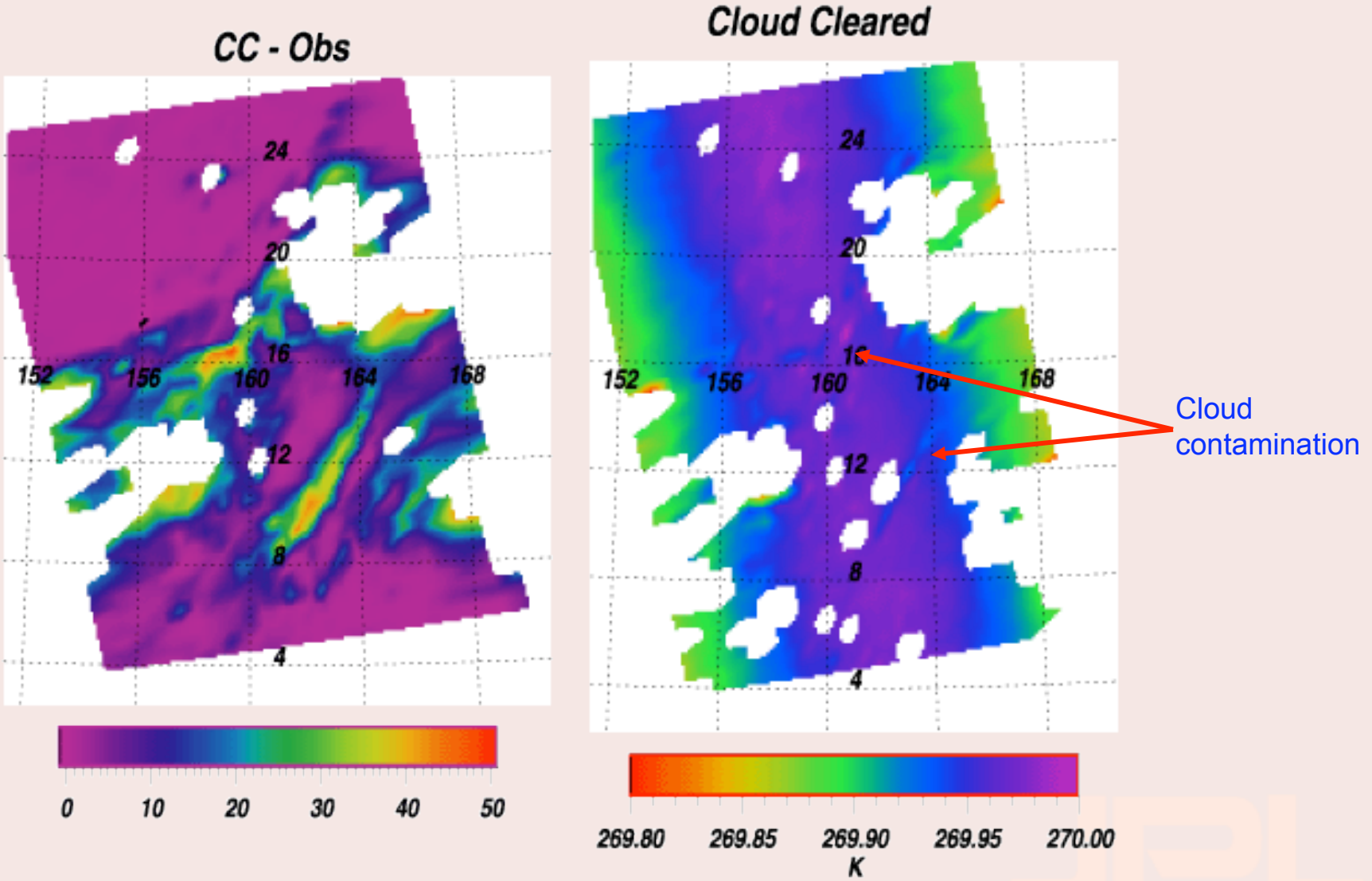
Weighting Function

Temperature-Sounding Lower Troposphere



Spatial Variability

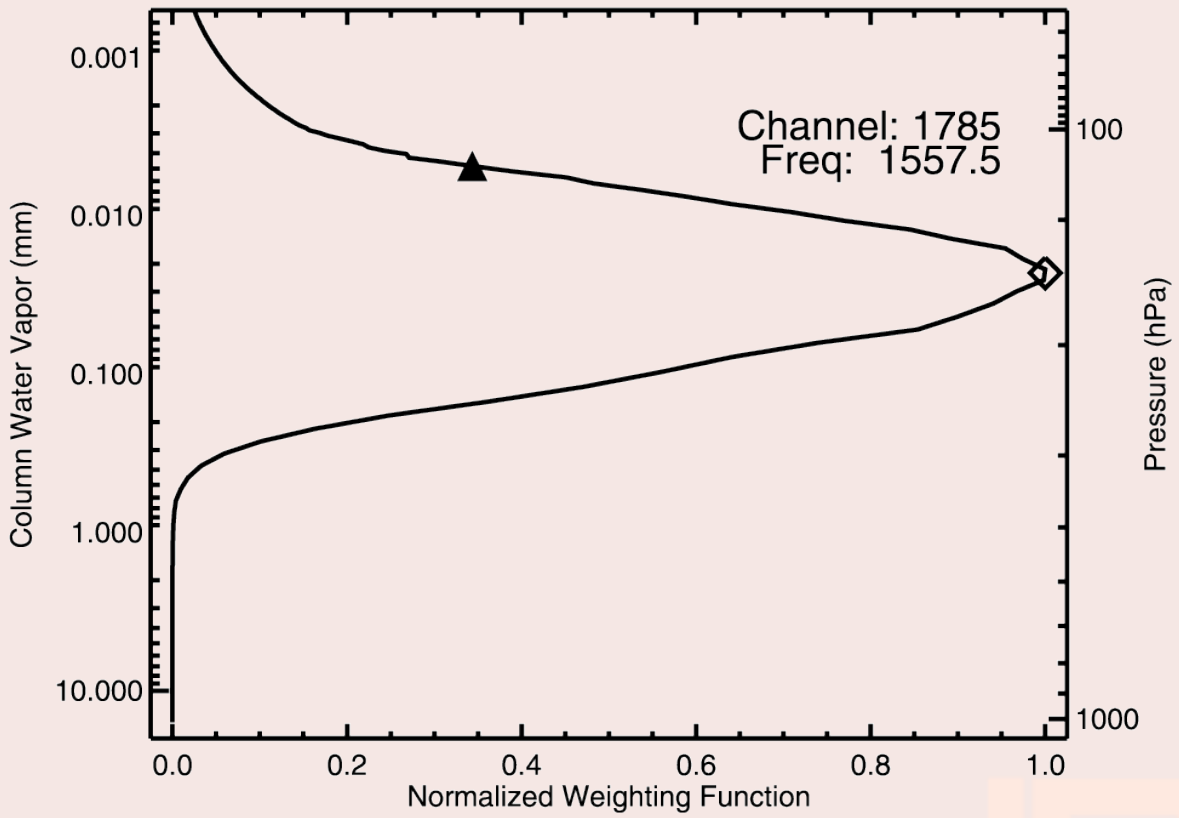
Tropical Humidity



Weighting Function

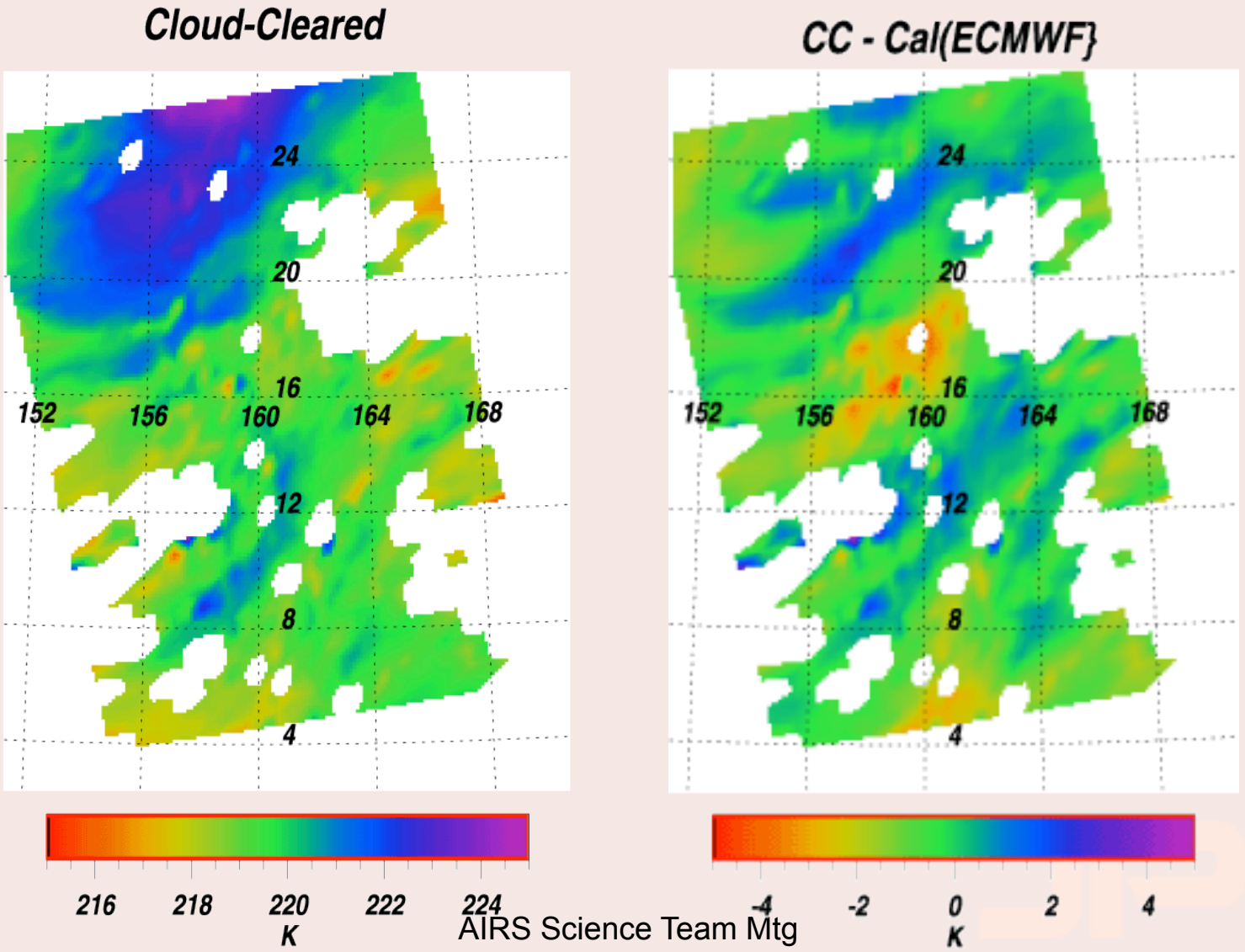
Water Vapor-Sounding Upper Troposphere

Senses at the 0.01 mm of column H_2O level



Upper-Trop Water Sounding Channel

Freq=1557.48 cm^{-1} (Ch 1785) 20020906 G-27



Water Vapor Spatial Variability

- Water vapor CC radiance shows greater variability then temperature
- Increases mixing ratio uplifts the 0.01 column water vapor surface,
  - 1557 cm^{-1} radiances is cooler
- Variability is correlated with clouds, but
- Radiance is consistent with:
  - vertical transport in squall
  - subsidence forward of squall

Conclusions

- Algorithms have difficulty detecting low clouds (previously known)
- Calculated radiances from solution do not agree with cloud-cleared radiances when low clouds are present
  - Implies more information can be extracted from measurement
- Algorithms appeared to be optimized for high clouds, e.g. tropical cumulus
- Mid through upper tropospheric cloud-cleared water vapor radiances show variability consistent with dynamics